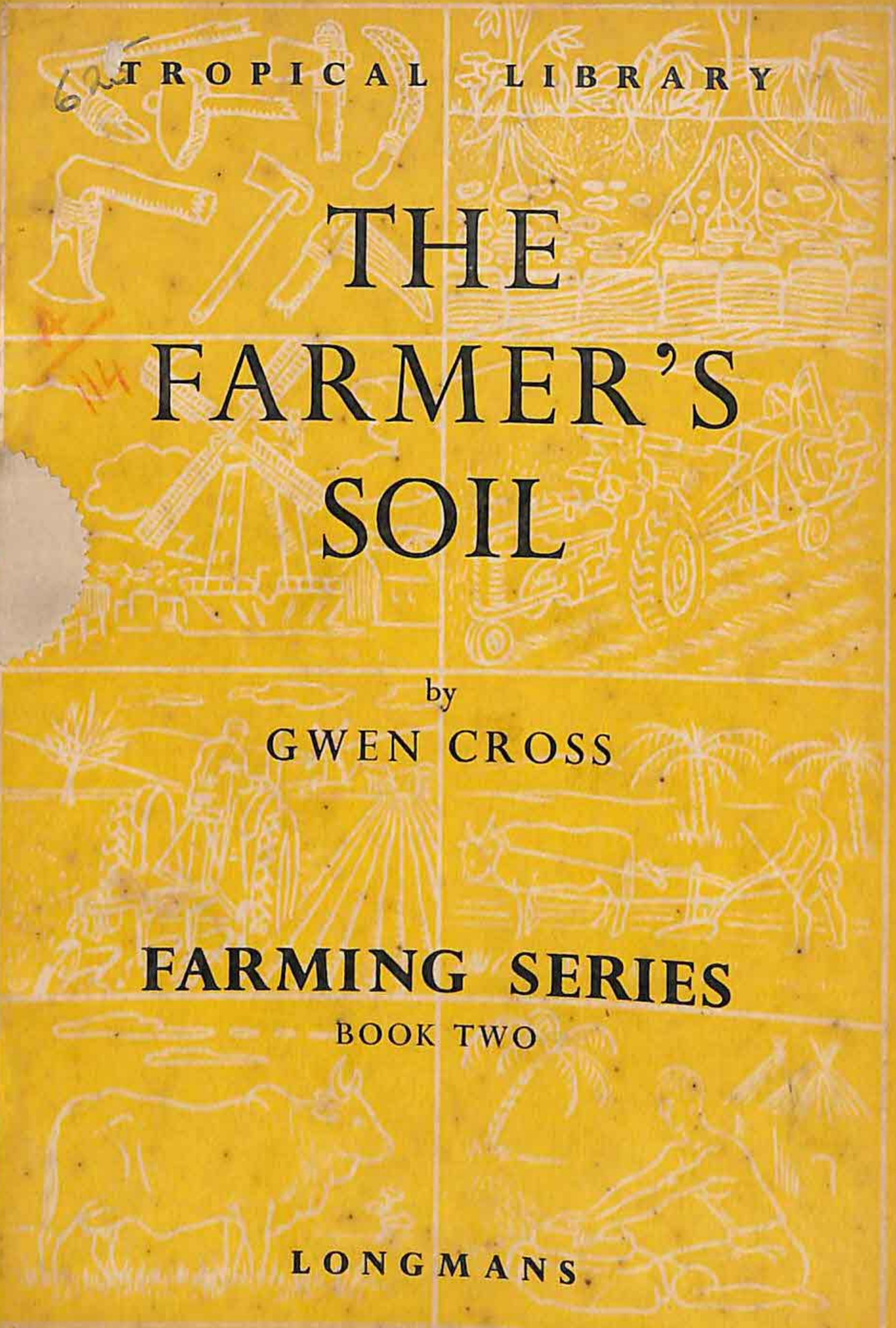
625
114

TROPICAL LIBRARY



THE FARMER'S SOIL

by

GWEN CROSS

FARMING SERIES

BOOK TWO

LONGMANS

625

TROPICAL LIBRARY: FARMING SERIES

GENERAL EDITOR—T. A. McKAY, B.Sc.

625

BOOK 2

THE FARMER'S SOIL

A/114

BY

GWEN CROSS

With illustrations

STATE INSTITUTE OF EDU... BANPUR
... Library 23/3, B. C. Road Calcutta

1724

LONGMANS

Longmans, Green and Co Ltd
6 & 7 CLIFFORD STREET, LONDON W 1
605-611 LONSDALE STREET, MELBOURNE C 1
443 LOCKHART ROAD, HONG KONG
ACCRA, AUCKLAND, IBADAN
KINGSTON (JAMAICA), KUALA LUMPUR
LAHORE, NAIROBI, SALISBURY (RHODESIA)
Longmans Southern Africa (Pty) Ltd
THIBAULT HOUSE, THIBAULT SQUARE, CAPE TOWN
Longmans, Green and Co Inc
119 WEST 40TH STREET, NEW YORK 18
Longmans, Green and Co
137 BOND STREET, TORONTO 2
Orient Longmans Private Ltd.
CALCUTTA, BOMBAY, MADRAS
DELHI, HYDERABAD, DACCA

First published 1950
New impressions by photolithography
1955, 1958 and 1960

[illegible]
[illegible] 28, 7.05
[illegible] 11678

Printed in Great Britain by
Lowe and Brydone (Printers) Limited, London, N.W.10

CONTENTS

PART 1. AIR AND WATER IN THE SOIL

CHAPTER PAGE

1. LIVING CREATURES NEED WATER 5
2. LIVING CREATURES NEED AIR . . . 7
3. WATER IN THE SOIL 9
4. THINGS WHICH ARE POROUS 12
5. AIR PATHS AND CAPILLARY WATER IN THE SOIL 15
6. HOW CAPILLARY WATER MOVES IN THE SOIL . 17
7. DRAINAGE WATER AND FREE WATER IN THE SOIL 19
8. WATER AND DIFFERENT KINDS OF SOIL . . 20

PART 2. PLANT FOOD IN THE SOIL

9. LIVING CREATURES GROW EACH AFTER ITS OWN KIND 24
10. THE FOOD OF LIVING CREATURES . . . 26
11. HOW PLANTS FEED AND STORE FOOD . . 27
12. WHAT WE LEARN WHEN PLANTS ARE BURNT . 30
13. THE FOODS WHICH PLANTS TAKE FROM THE SOIL 32
14. THE SOIL IS A STOREHOUSE OF PLANT FOOD . 36
15. THE LITTLE LIVING THINGS THAT HELP IN THE SOIL. FERTILE SOIL . . . 38

PART 1. AIR AND WATER IN THE SOIL

CHAPTER 1

LIVING CREATURES NEED WATER

IF there was no water, there would be no living creatures on the Earth. Men, animals and plants cannot live where there is no water. Men have died in boats on the sea because they had no fresh water. Men and animals have died on journeys across the deserts in Africa, Australia and Asia because they could not get fresh water.

In some countries, like India and parts of Africa, there are wet and dry seasons of the year. In the season of rain, the grass grows quickly and the fields are green. In the dry season the grass dies and the fields are bare and brown. In Australia sometimes thousands of sheep and cattle die, and the fields bear no crops, because there is no rain. The rivers dry up and the grass dies. Sometimes fires burn up miles and miles of forest.

If we put seeds in dry bags or tins, we can keep them for a long time. If we plant them in dry soil, they will not grow. But they will begin to grow when the rain has made the soil wet. If there is not enough rain, the plants do not grow big. Their leaves are small and they do not produce good fruits. Without water the plants cannot take in the foods which are in the soil, and so the stems and leaves cannot stand up straight. We often see the leaves hanging weakly in the mid-day sun, and the young stems bending over.

A very big part of the bodies of men, animals and plants is water. If we cut fifty pounds of grass and let it dry in the sun, it will weigh only fifteen pounds! If we dry this grass still more in an oven, it will weigh only seven pounds! Of the fifty pounds of fresh grass, forty-three pounds is water.

Plants need water for drinking, for dissolving the foods which are in the soil and for making stems and leaves strong.

THINGS TO DO

1. Cut some young branches of a bush which grows in the garden. Stand some of the branches in water and some without water. Note the time, and see in how many minutes the branches without water begin to look weak. Now look at the branches which are standing in water. Do they look weak?

2. If you have scales, weigh some newly cut grass. Dry it in the sun and weigh it again. Now dry it still more in an oven and weigh it. What weight of water has the grass lost?

3. Plant some seeds in wet soil and some in dry soil. In how many days do the seeds in the wet soil

begin to grow? Do the seeds in the dry soil grow?

4. Soak some seeds in water for half a day, then put them on a piece of wet cotton cloth. Put some dry seeds on wet cotton cloth. What happens to the two lots of seeds?

QUESTIONS

1. Name two countries where there are deserts.
2. Name two countries where there are wet and dry seasons.
3. Why can seeds be kept for a long time in dry bags?
4. What is the difference between seeds grown on soil which has enough water and seeds grown on soil which has not enough water? In what way are the seedlings[1] different?
5. Why do plants need water?

CHAPTER 2

LIVING CREATURES NEED AIR

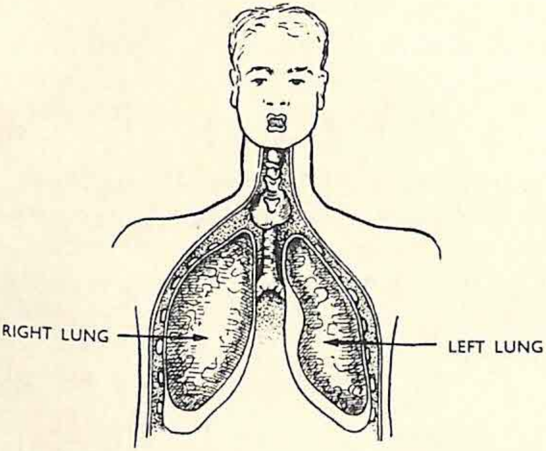
ALL living creatures breathe air, though different kinds of creatures breathe in different ways. Fish breathe the air that is dissolved in the water in which they live. They breathe by their gills.

Men and animals breathe through their noses, and the air goes into their lungs. The lungs are really air bags in the body. Men and animals can live only a very short time without air.

Plants breathe through little holes in the skin. All parts of a plant breathe. Stems and leaves

---

[1] Seedling: a young plant grown from seed.



HOW A MAN BREATHES

breathe the air around them; roots breathe the air in the soil.

In the soil are many little paths in which there is air. These paths run between the particles. Roots need this air. If the paths become full of water and all the air is driven out, the roots cannot breathe and the plants will soon die.

Plants which live in water often have air spaces in their roots, stems and leaves. These spaces store air for the plant to use. There are not many plants that can live with their roots in water. Mangrove trees grow in mud, and, since the roots that grow in the mud cannot find enough air, other roots grow up above the mud.

QUESTIONS

1. Write down all the new words in this lesson and learn them.

2. Write down the names of any plants you know which grow well with their roots in water (mud, swamp and river plants). Divide them into two groups, (*a*) plants which have only their roots in water and (*b*) plants which have roots, stems and leaves in and on the water.

3. Name a plant which sends some of its roots into the air, because the other roots are in water.

4. By what do fish breathe? What is the name of the air bags in the bodies of animals? Which parts of a plant breathe?

CHAPTER 3

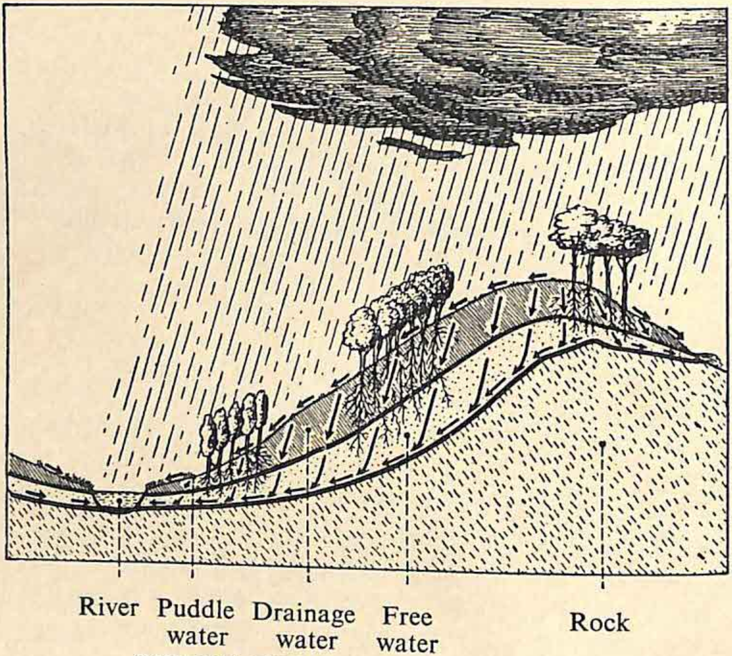
WATER IN THE SOIL. WHERE THE RAIN GOES

PLANTS take their water from the soil. The soil gets its water from the rain. When it rains some of the water sinks into the soil. Some flows away over the top of the soil. More water flows away over bare, smooth soil than over covered, rough soil. More water flows away down a hillside than on level ground. We call this water top wash. Soil erosion is the carrying away of soil by the top wash.

In heavy rain, if the soil is rough on top, some of this water stays in little holes, where it forms puddles.[1] Some of the water in the puddles sinks slowly into the soil. Some of it evaporates[1] in the air. When the water evaporates, the top of the soil, where the puddle was, is left smooth and hard. Plants find it difficult to grow in soil like this.

---

[1] Puddle: a small pool of water in a hollow.



WHERE THE RAIN-WATER GOES

The water that sinks into the soil does one of three things:

Some of it does not sink deep into the soil. It stays near the top and soon evaporates in the sun. So it is lost in the air.

Some of the water sinks into the soil until it comes to a layer of hard rock or heavy clay. Then it flows along the top of this layer and comes out, where the ground is lower, as a river or a spring. This is called *drainage*[1] *water*.

---

[1] Evaporate: to turn into vapour, like steam.

Sometimes the water cannot drain[2] away, or it drains away very slowly. It stays in the soil and is called *free water*. This is the water we get when we dig wells.

All the rain-water that sinks into the soil does not drain away or remain as free water. Some of it holds on to the soil particles. This is the only water that the plants can use, and so it is very important to the farmer. It is called *capillary water*, and you will read more about it in Chapter 5.

On different soils the rain-water does different things. On some it flows over the top. It sinks into other soils and drains away, or much of it may remain as free water. Some soils have much capillary water, while others have only a little. Capillary water helps the plants, free water may harm them.

THINGS TO DO

1. Watch the soil near your house and in your garden. Does much of the rain-water flow away as top wash? If most of the water sinks into the soil, does it drain away below the surface? Can you find where the soil drainage water goes? Is there a spring or river near?

2. Collect a little of a few different kinds of soil and dry them. Get a number of tins and make

---

[1] Drainage: water which is drained away (see [2]).

[2] Drain: to make dry by running the water away, to flow.

drainage holes in the bottom. Now put the soil in the tins, each kind in a different tin. Pour a spoonful of water on each soil in turn. Keep on doing this until water begins to drain from one tin. Put this tin aside and pour water as before on the remaining tins. As water begins to drain from each tin in turn, put it aside. When you have finished, you will have put the different soils in order, from the one from which water drains most quickly to the one from which it drains most slowly.

Name the different kinds of soil. Does the soil with most sand in it hold more or less water than the others?

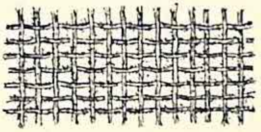
QUESTIONS

1. Write down the new words in this lesson and learn them.
2. What do we call the water which flows over the top of soil and helps erosion?
3. What do we call the water which is held in the soil round the particles?
4. What is "free water"?
5. Which of the different kinds of water in the soil do we get in wells?

CHAPTER 4

THINGS WHICH ARE POROUS

SOME things are full of little holes. We can easily see the holes in a sponge or a loofah. If we look through a lens at a towel or a piece of blotting paper, we see that they have many little holes, which we cannot see without the lens.



A PIECE OF TOWEL SEEN THROUGH A LENS

These holes are very narrow pipes, sometimes as narrow as a hair. When water finds very narrow pipes like these, it can flow in them, either up or down or to the side. These small holes are called pores, and a thing with pores through which water flows is said to be *porous*.

If we stand a porous thing in a little water, or in water coloured with red or black ink, we can see the water slowly rise UP in it. If we let it stand in water for long enough, the whole thing will become wet. We say that it absorbs or drinks in the water. Oil flows UP in a lamp wick[1] because the wick is porous. A towel dries our skin easily, because the towel is porous and absorbs water quickly.

THINGS TO DO

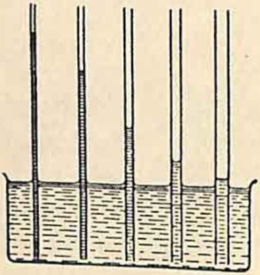
1. Put a little ink into some water, and stand in it one or more of the things you have read about in this lesson. Watch the coloured water go slowly up.

2. Put one end of a narrow glass pipe or tube in water and watch how the water rises inside the

---

[1] Wick: the narrow band of cloth at the top of which the oil burns.

tube. The narrow tube is like a pore in a porous thing. The narrower the tube the higher the water will rise. If the tube is too wide, the water will not rise in it at all.



CAPILLARY
TUBES

3. If you have no very narrow glass tubes, you can use rulers. Put the flat sides of two rulers together and tie them with cotton thread at one end and in the middle. Stand the rulers upright in a dish, fastening them so that they will not fall. Into the dish pour water to the depth of about one inch. Put a mark on the rulers to show how high the water is. Let the rulers stand in the water for three or four hours, then take them out. Hold them upright, so that the water between them does not go on to a part that is still dry. Untie the cotton carefully. What length of the rulers is now wet? Perhaps the wet part now measures three or four inches. They stood in water one inch deep. So the water has gone up the narrow space between the rulers for two or three inches. This is an example of how capillary water moves up in narrow spaces like the pores in soil, blotting paper, etc.

QUESTIONS

1. Write down all the new words in this lesson and learn them.
2. Name three things which are porous.
3. Read again in Chapter 10 of Book 1, *The First Farmers*, about the porous earthenware pots.
4. Why does oil go UP in a lamp wick?
5. Why does blotting paper dry the ink in your book quickly and well? Could you dry the ink in your book with any kind of paper?

CHAPTER 5

AIR PATHS AND CAPILLARY WATER IN THE SOIL

SOIL is made of small particles of rock. The particles have little paths and spaces between them. These paths and spaces are full of air, which the roots of the plants breathe. When the roots take the air from one part of the paths, more air moves along to take its place. This air is very important.

In clay soil the particles and the paths between them are very small. In sandy soils the particles are bigger and there is more space between them. This is the reason for the difference between the two kinds of soil. In clay soil there is very little air in the narrow paths between the particles. In sand there is much more air in the wider paths.

When it rains, some of the water sinks into the soil. Part of the water that has sunk in becomes drainage water, and part of it becomes free water. But the particles do not let all this water sink deep into the soil. They keep some of it, a thin layer of water holding on to each little particle. We cannot see this water with the naked eye.[1] We only know that the soil feels and looks damp. There is still air in the paths between the particles.

The little paths in the soil are like pores. Because they are very narrow, the capillary water can move in them, up or down or to the side. *Capillus* is a Latin word meaning a hair, and the paths are narrow, like little hairs. So the water in these hair-like paths is called capillary water.

The capillary water stays round the particles only when the paths are very narrow. If the paths are not very narrow, the water drains away. There is then no capillary water in the soil to move from place to place.

Clay soils hold little air and much water, and are wet and heavy to dig. Sand holds much air and little water, and is dry and light to dig.

THINGS TO DO

1. Stand two rulers in water as in THINGS TO DO on page 14, but this time do not tie the rulers close together. Does the water go up in the wider path you have now left between them? Capillary water moves only in a narrow path.

---

[1] To see with the naked eye: to see without the help of a lens.

QUESTIONS

1. Write down all the new words in this lesson. Learn them.
2. What is the Latin name for a hair? What do we call the thin layer of water round the soil particles?
3. Name the three kinds of water which there may be in the soil?
4. What is the opposite of: narrow, up, damp, heavy?

CHAPTER 6

HOW CAPILLARY WATER MOVES IN THE SOIL

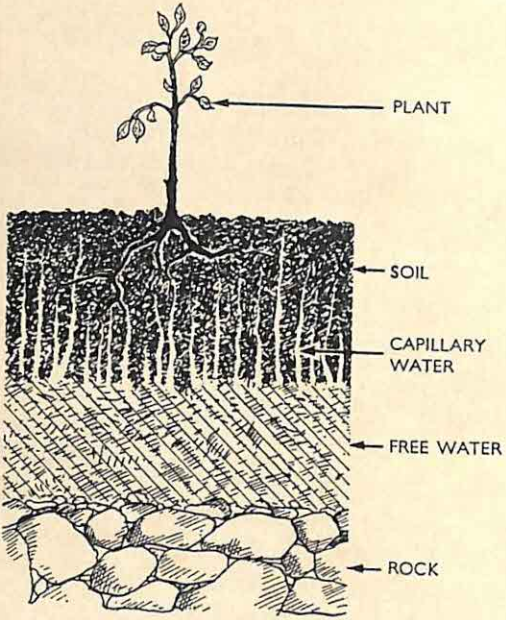
1.—*When the plants drink.*

The root hairs of plants absorb water and the food which is dissolved in the water. The little root hairs cling[1] round the particles of soil, round which are also thin layers of capillary water. The root hairs absorb this water.

The layer of capillary water round each particle touches the layer of capillary water round the next particle. When the root hair takes the water around one particle, more water moves in the soil to take its place. This capillary water moves from all sides of the root hair, from under it, from above it, from the left and from the right.

The root hair keeps on absorbing the water, and more capillary water moves from all sides to take its place. In this way the capillary water in the soil keeps on moving as the root hairs absorb it.

[1] Cling: to hold firmly to.



WATER IN THE SOIL

2.—*When water evaporates from the soil.*

The sun and the wind evaporate the water at the top of the soil and carry it off into the air. Some of this may be free water which the plants do not use. But the capillary water round the particles at the top of the soil also evaporates. As this water evaporates, more water moves up to take its place. Then this evaporates in its turn. In this way capillary water from deep soil moves up to the top and is lost in the air.

QUESTIONS

1. Write down all the new words in this [illegible] and learn them.
2. Name two things which take away capillary water.
3. To what do the root hairs cling in the soil?
4. When a root hair takes the water which is round a particle of soil, how does more water come to it?
5. In dry seasons how can capillary water from deep down in the soil be lost in the air?

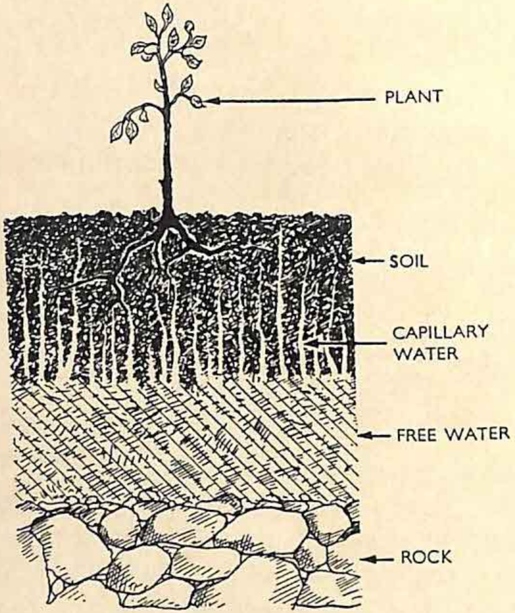
CHAPTER 7

DRAINAGE WATER AND FREE WATER IN THE SOIL

DRAINAGE water is the water which flows away through the soil. Drainage water can flow away easily in sandy soils and loams, and where the ground is not level. But sometimes this water cannot flow away, perhaps because the layers of soil and rock are level or because the soil is heavy clay. When it cannot flow away, it is called free water.

Free water harms the plants. It fills the little air paths between the particles and leaves no space for air. The roots cannot get enough air to breathe, so the plants become weak and die.

If the free water is deep in the soil, plants with shallow roots are not harmed. Plants with very long roots, like some trees, can send their roots down through the layer of soil with free water to hard rock or a different kind of soil. They some-



WATER IN THE SOIL

2.—*When water evaporates from the soil.*

The sun and the wind evaporate the water at the top of the soil and carry it off into the air. Some of this may be free water which the plants do not use. But the capillary water round the particles at the top of the soil also evaporates. As this water evaporates, more water moves up to take its place. Then this evaporates in its turn. In this way capillary water from deep soil moves up to the top and is lost in the air.

QUESTIONS

1. Write down all the new words in this lesson and learn them.
2. Name two things which take away capillary water.
3. To what do the root hairs cling in the soil?
4. When a root hair takes the water which is round a particle of soil, how does more water come to it?
5. In dry seasons how can capillary water from deep down in the soil be lost in the air?

CHAPTER 7

DRAINAGE WATER AND FREE WATER IN THE SOIL

DRAINAGE water is the water which flows away through the soil. Drainage water can flow away easily in sandy soils and loams, and where the ground is not level. But sometimes this water cannot flow away, perhaps because the layers of soil and rock are level or because the soil is heavy clay. When it cannot flow away, it is called free water.

Free water harms the plants. It fills the little air paths between the particles and leaves no space for air. The roots cannot get enough air to breathe, so the plants become weak and die.

If the free water is deep in the soil, plants with shallow roots are not harmed. Plants with very long roots, like some trees, can send their roots down through the layer of soil with free water to hard rock or a different kind of soil. They sometimes live only because they can do this. But if the free water is in the top eighteen inches of soil, the plants die. Free water near the top of the soil makes mud and swamps.[1] Only a few plants like swampy soil.

If the free water is deep in the soil, it is sometimes a help. When the capillary water in the soil above it is used up by the plants, or evaporates into the air, some of the free water can go up through the soil as capillary water. In this way free water is like a tank, storing water until it is needed.

QUESTIONS

1. Write down all the new words in this lesson and learn them.
2. What kind of water do we call free water?
3. How can free water harm plants? When does it do no harm to plants? When can it be a help to plants?
4. What is a swamp?
5. What kinds of soil drain easily?
6. Would you expect to find free water in the soil at the top or at the bottom of a hill?

CHAPTER 8

WATER AND DIFFERENT KINDS OF SOIL

RAIN-WATER does different things on different kinds of soil. On some soils much water is lost. This is the top wash water, which flows away over the top of the soil. In other places much water sinks into the soil. If it drains away well or sinks very deep, the top soil is left damp. If it does not drain away well or if it cannot sink deep, there will be free water near the top of the soil.

---

[1] Swamp: soft, very wet land.

Some soils dry quickly after rain; some hold the water for a long time. The plants which a farmer can grow must be plants that like his soil. We shall read in a later book how the farmer can improve soil that is too wet or too dry.

THINGS TO DO

1. We need to know a number of things about different kinds of soil and water:

Does water quickly flow through?

Does much water flow through, or does much water stay in the soil?

Which soils hold most water without there being free water in them?

Take several kinds of soil, sandy soil, clay soil and loam, and dry them. Make little holes in the bottoms of a number of tins, then weigh the tins. Fill them with the dry soil, putting a different kind of soil in each. Weigh each tin again. With a spoon pour water slowly on each soil. When the water begins to come out from the bottom of a tin, do not pour any more into it. Weigh the tin with the wet soil in it. Subtract the weight of the tin and dry soil from the weight of the tin and wet soil. The answer will give you the weight of the water in the soil.

If you do this with each tin of soil, you will find which soil holds most water.

S.C.E.R.T., W.B. LIBRARY
28.7.05

You will find that clay holds the most water and sand the least water. Loam holds more water than sand but not so much as clay.

People who have done this carefully have found that:

1 cubic foot of sand holds 25 lb. of water.
1 cubic foot of gravel holds 40 lb. of water.
1 cubic foot of loam holds 45 lb. of water.
1 cubic foot of clay holds 50 lb. of water.

Sandy loams hold more water than sandy soils but not as much as loam. Clay loam holds more than loam.

2. Again dry and put in tins some of a number of different kinds of soil. Do not weigh the tins this time. Take a pint of water (a one-pound meat tin holds about a pint), and pour it slowly on to the soil in one of the tins. As soon as you see water beginning to come from the bottom of the tin, stop pouring. How much of the pint of water is left? Do the same with each tin of soil. Which soil holds most water?

QUESTIONS

1. These are words which you have read in this book. You will find them again in later books.

evaporate drainage capillary porous
swamp difference level puddle
space shallow rough smooth

2. Complete the following sentences using words from the first line:

When the sun is hot, the water in the pools . . . .
Blotting paper and soil are . . . . things.
. . . . water is the only water which the plants can use.

3. Complete these sentences using words from the second line:

There is more top wash on a hillside than on . . . . ground.

Free water near the top of the soil makes a . . . .

4. Complete these sentences using words from the third line:

If free water is deep in the soil, it does not harm plants with . . . . roots.

Some of the rain-water stays in puddles on the top of . . . . soil.

PART 2: PLANT FOOD IN THE SOIL

CHAPTER 9

LIVING CREATURES GROW EACH AFTER ITS OWN KIND

IN Book 1, *The First Farmers*, we were told about living creatures and things which have never lived. In what important way are things which are alive different from things which are not alive?

We can think of many things which living creatures can do. Some can walk, some can run, some can hop, some can swim, some can fly. Many can see and hear and many can cry out. But all living creatures cannot do all these things. Plants are living creatures, but they cannot do any of these things.

All living creatures need food and drink, but they do not all take in their food and drink in the same way. The food of animals and men is different from the food of plants, and they take it into their bodies in a different way.

Most living creatures breathe, but they breathe in different ways. Plants do not breathe like fish and fish do not breathe like men. There are also some very little living things which do not breathe air at all. Most living creatures need light, but some which live in the dark soil and in the deep sea never see the light of the sun.

What do *all* living creatures do? We plant a little cabbage seed. It grows, and the new plant is like other cabbages. We plant a coconut. It grows, and after many years there is a tall tree like other coconut trees. We see a new-born kitten. It grows and in a few months it has become a big cat. It is like other cats. We see a new-born baby. We know it will grow up and look like other men or women.

So there is one thing that all living creatures do. They all grow. They all become like other creatures of their own kind. Genesis I, 25. I Corinthians XV, 38, 39. Living creatures all grow from small beginnings.

Things which are not alive do not grow. If we see a living creature that is not growing well, we know that it is sick. If living things grow well, it is a sign that they are strong.

QUESTIONS

1. Write down all the new words in this lesson and learn them.
2. Name two living creatures that hop, two that fly, two that swim, two that run.
3. Name two living things that breathe in a different way from man.
4. Where are there living things that have never seen the light of the sun?
5. Read Genesis I, 25 and I Cor. XV, 38, 39.
6. Name one thing that all living creatures do.

CHAPTER 10

THE FOOD OF LIVING CREATURES

WHEN we build a house or make a fence or a road, we begin with little things. We add to them more things *like themselves*, more bricks or poles or stones. The things we are making get bigger, but the things of which we make them do not change.

But plants and animals do not grow bigger because we add to them things like themselves. They grow bigger because they take into their bodies things different from themselves. These things are food and water, which they change before they can make them part of their living bodies.

We know that men and animals take food and water into their bodies when they eat and drink. They have mouths. They can move from place to place to seek their food. Animals, birds and insects eat other living animals, insects and plants. Men cook and eat parts of animals; they eat parts of plants either cooked or uncooked. Men and animals always eat living things or things that have lived.

Plants are different. A plant cannot move from place to place seeking food. Its roots hold it firmly in the soil. A plant has no mouth with which to take solid food into its body. Only a few plants can get their food from living things. These are plants which we sometimes see growing on other plants. Most plants get their food from the part of the soil that has not lived, from things that have lived and then rotted in the soil and from part of the air, which has not lived.

So plants take from the soil and air things that have not lived, change them, and make their living bodies from them. Animals and men feed on the plants, and by doing so take into their bodies things that have never lived. Men and animals could not get these things in their food if plants did not first take them from the soil and the air.

QUESTIONS

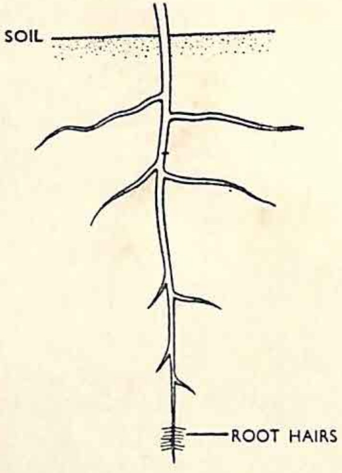
1. Write down the new words in this lesson and learn them.
2. In what way is adding bricks to the wall of a house different from eating food?
3. In what way is the food of plants different from the food of men and animals?
4. How do men get in their food the things which have not lived and which are in the soil and the air?

CHAPTER 11

HOW PLANTS FEED AND STORE FOOD

IF we grow beans or maize in a glass jar, we see the roots grow down and branch out. At the ends of the roots are little white hairs.

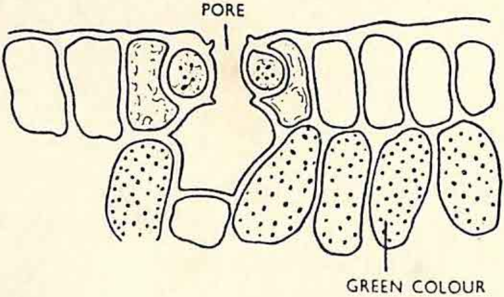
These root hairs absorb the water which is round each little particle of soil. From the root hairs the water passes into the roots. The root hairs cling to the particles of soil.



THE ROOT OF A PLANT

But they absorb more than just water. Some of the things in the soil dissolve in water, and pass into the root along with the water. This mixture of water and plant foods is called sap. The sap passes up the roots and the stem into the branches. From the branches it goes into the leaves.

The leaves are the workshops[1] of the plant. They have little pores in their skin. Under the



PART OF A LEAF SEEN THROUGH A LENS

---

[1] Workshop: a place where things are made.

skin there are little flat, round, green things, like very small green buttons, and it is these which make the leaves look green.

When the sun shines on a green leaf, the leaf takes in a part of the air. This part has carbon[1] in it. In the sunlight the green leaf makes the sap and the carbon from the air join together to make plant food.

We cannot cook our food without a fire. A plant cannot prepare its food without sunlight. When the sunlight, green leaves, sap and air come together, the plant makes a liquid food which is like sugar. This food moves through the plant, going to all parts of it. The food travels near the skin, so that if we cut or damage the skin of a plant, we also damage the path for the food.

Some plants make more food than they need themselves. Yams, sweet potatoes, cassava are some of the plants which store food. Their roots are full of starch, to which the sugar-food changes when it is stored. Some plants store food in the sap. The sap of the sugar-cane is full of stored sugar. When plants need the stored food, it changes back again to foods which dissolve in the sap and can travel to all parts of the plant. Other plants store food for new plants in their seeds and fruit. This is the reason why there is much oil in coconuts, peanuts and simsim seeds, and starch and other foods in peas, beans, rice and maize.

---

[1] Carbon: a substance found in coal, wood and the bodies of animals.

QUESTIONS

1. Write down the new words in this lesson and learn them.
2. Write the names of three plants which store food as starch in their roots or stems, and three plants which store food in their seeds or fruits.
3. From where do plants get their food?
4. What is sap?
5. What makes the leaves of a plant look green?
6. What four things does a plant need to be able to make food in its leaves?

CHAPTER 12

WHAT WE LEARN WHEN PLANTS ARE BURNT

MOST of us burn wood to make fires on which to cook our food. The wood burns quickly, with flame and smoke, and gives off heat. If we take a piece of wood from the fire, we see that it is black and soft. We say that the wood is charred, and we call the black part char or carbon. If we put the wood back in the fire it burns again, and we no longer see the black char. Soon the wood is burnt away and the fire dies. We see only a little soft white ash. From many pieces of wood we get only a few small tins of ash.

We see this also when we burn big trees. If we collect all the ash after a big tree has been burnt, we find that it is very little compared with the size of the tree.

This is true if we burn any kind of plant. What happens to the tree when it burns?

1. A very big part of any plant is water. This is the water which the plant took from the soil with its root hairs. When the plant burns, the water evaporates into the air and is lost.

2. The black, charred part of the partly burnt tree is carbon. This is the carbon which the leaves of the tree took from the air when the sun was shining. It helped to make the body of the plant.

3. If the wood is put back in the fire the charred part burns away: the carbon goes back into the air and is lost. When we burn plants, much good food is lost in the air.

4. The soft white ash has in it the things which the plant took from the soil. These things dissolved in the water and went into the plant through the root hairs. If we pour water on the ash, we shall see that much of it dissolves. The plant used these things together with carbon from the air to make body, skin, leaves, fruits and seeds.

QUESTIONS

1. Write down the new words in this lesson and learn them.
2. Name the things a plant is turned into when it burns. Where did each of these things come from? Where does each go?
3. Why is much plant food lost when a plant burns?
4. What is char?

CHAPTER 13

THE FOODS WHICH PLANTS TAKE FROM THE SOIL

THE soil has many different things in it, but plants can use only a few of these things for their food. Some plants take more of one kind of food from the soil, other plants take more of a different kind. But plants in a cold country like Norway need the same things as plants in a hot country like India or Africa.

There are some foods which all plants take from the soil, and we find these things in the ash of burnt plants. The ash of different plants has often different things in it and different amounts of the same things. But in the ash of *all* plants we always find these three things, nitrogen foods, phosphate foods and potash foods. These three are the most important foods and without them plants cannot grow strong.

There are small amounts of other foods in plant ash. One of these is iron, which plants need to make their green colour. If there is not enough iron in the soil, the leaves are yellow. When the plants are given iron, the yellow leaves become green.

For many years men have been finding out how different foods help the plants. They put plants in bottles with their roots growing down into water. In the water in different bottles they put different plant foods.

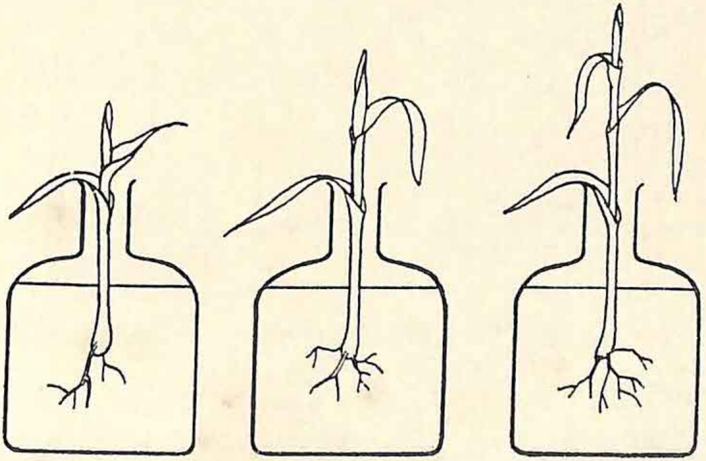
They may take five bottles and in bottle 1 put no nitrogen food, in bottle 2 no phosphate food, in bottle 3 no potash food, in bottle 4 no iron food, and in bottle 5 all these foods in the amounts the plants need.

The seeds begin to grow, and after a few weeks the seedlings in the different bottles look very different from each other.

In bottle 1, with no nitrogen food, the plants grow slowly, and the leaves are small and yellow. The nitrogen foods a plant needs are called nitrates.

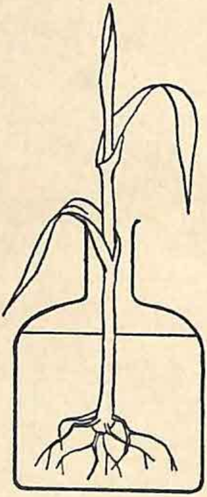
In bottle 2, with no phosphate foods, the plants grow a little taller than in bottle 1. But the plants are not strong and the leaves are thin and few.

In bottle 3, with no potash foods, the plants are bigger than in bottles 1 and 2. They have more leaves, but still the plants are not strong.

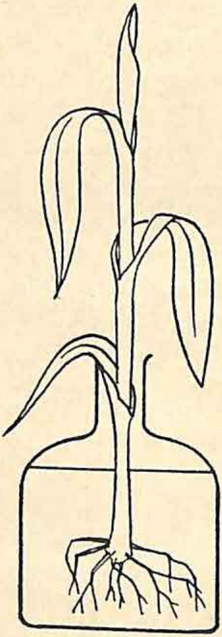


In bottle 4, with no iron foods, the plants are tall, but the leaves are yellow.

In bottle 5, the plants are tall, strong and have many strong green leaves. These plants have all the foods they need, nitrates, phosphates, potash and iron.



4



5

From this we learn that plants need different foods to help different parts.

Nitrogen foods (*nitrates*)

These help the plant to grow quickly, to have strong roots and many big, green leaves. We know that the leaves are where the plants make their food. If there are many strong leaves, the plant can make much starch in the sunshine.

Phosphate foods

These make a plant big and strong. They help it to make its fruits early, and to have many good fruits.

Potash foods

These help to make starch and other foods for storing in fruits, roots and stems. Wheat, maize, sweet potatoes, European potatoes, yams and barley all need potash.

When it is growing the plant uses these foods to make roots, stem, leaves and fruits. The plant changes these things to become part of itself, but it takes other things which it does not need for this. Some of these waste things, such as water, go into the air. Others go into the leaves. When the leaves fall these waste things go too and rot in the soil.

QUESTIONS

1. Write down all the new words in this lesson and learn them.
2. Name the three most important plant foods.
3. How does each of these foods help the plant?
4. How does iron help a plant?
5. When plants are burnt, where will these three important foods be found?
6. What is the plant food found in nitrates?
7. Where do the waste foods go?

CHAPTER 14

THE SOIL IS A STOREHOUSE OF PLANT FOOD

EACH year we dig our sweet potatoes, or cassava, and put them in a store, where they will remain good for many months. They are not ready for us to eat until we cook them on a fire. This changes the sweet potatoes or cassava, and makes them good to eat. We do not cook them all on one day, for, if we did that, we should waste much food. Each day we take from the store only the amount we need for food. We cook this and eat it, leaving the rest to be cooked and eaten as we need it.

The soil is much the same to a plant as our store is to us. In the soil are many things which will make plant food, but they are not plant food yet. They have not dissolved in water, so the plant cannot yet use them. They are like the sweet potatoes or cassava in our store. They are there, but they are not ready to become plant food until they have been changed.

Air and water, heat and cold, change these things in the soil, turning them into foods that dissolve in water. When this has been done, the plant can use them. The change takes place very slowly, and only a little food is made each year. If they change too slowly, there will not be enough plant food in the soil and the plants will be hungry. If the change takes place too quickly for the plants to be able to use all the food, some of it will dissolve in the rain-water and will be lost. The soil is a storehouse of plant food, and the plants will be strong if they are getting enough of it all the time. We shall read in Book 5 how we can help the soil in our gardens to make enough food for the plants.

THINGS TO DO

To find plant food in the soil

Put some soil in a bucket, and cover it with water. Let the soil soak[1] for some time. Stir it well, then pour the water through blotting paper in a funnel[2] to divide the water from the solid soil. The part of the soil which the plants can use will have dissolved in the water. Now boil the water in a pot until there is none left. At the bottom of the pot you will find a little white powder. Only about one part in every two hundred parts of soil will dissolve in water and become plant food.

QUESTIONS

1. Write down all the new words in this lesson and learn them.
2. What helps to change things in the soil so that they become plant food?
3. Why cannot the plant use these things before they have been changed?
4. If the food is ready more quickly than the plant can use it, what may happen to it? Will the plants be able to use it later?

---

[1] Soak: to place in water or other liquid until thoroughly wet.

[2] Funnel: a piece of tin used, for example, for pouring oil into a lamp; it has a wide mouth shaped like a circle and becomes narrower, ending in a tube.

CHAPTER 15

THE LITTLE LIVING THINGS THAT HELP IN THE SOIL. FERTILE SOIL

THE air, the rain, the heat, the cold, all help to break up the rocks and make soil. They are helping all the time to change the things in the soil into plant foods. They help to change shells, coral and chalk into lime.

The things which change parts of the soil to make plant foods are the gases of the air (carbon dioxide helps very much), acids in the water in the soil, and very little living things which are in the soil. These little living things are called microbes, one group being also known as bacteria.

We cannot see these microbes with the naked eye. We must use a microscope, which is a glass with a number of lenses. A microscope makes little things look bigger. These little microbes live on the rotting plants, turning them into humus and making plant food. So the soil needs these microbes, together with humus, other nitrogen, phosphate and potash foods, and lime. When there is enough of all these things in the soil, we say the soil is *fertile*. If the soil has no microbes and humus in it, it is not fertile. We must try to have fertile soil with enough of the other plant foods in it also. We know that if we take food from our own store every day, the time will come when there is no more food left. We must not forget that the soil is an important food store. If we let the plants take food from the soil all the time, a day will come when there will be none left. If we have no other land, we shall be hungry. Man cannot live without fertile soil.

Questions

1. Write down all the new words in this lesson and learn them.
2. Name four things which break up rocks to make soil.
3. Name three things which change parts of the soil to make plant foods.
4. What must a soil have to make it fertile?
5. What do you think is meant by "hungry soil"?

New words in this book:

nitrogen
potash
nitrates
ash
phosphates
microbes

Complete these sentences by using one of the words in each:

1. When a big tree is burnt, only a little white . . . . is left on the ground.
2. In the soil are little living things called . . . . These . . . . change the rotting plants to plant food and humus.
3. Plants need . . . . to help them make their stores of starch. They need . . . . to make them grow quickly and have good green leaves. They need . . . . to help their fruits to grow well. They need iron to make their leaves . . . .

Farming Series

1. The First Farmers
2. The Farmer's Soil
3. The Farmer's Friends in the Soil
4. Better Ways of Farming
5. Feeding the Soil
6. More Food for the Soil
7. Draining the Soil
8. Irrigating the Soil
9. Soil Erosion
10. Soil Conservation

1724
LONGMANS

A-